Chapter 6
SEDIMENT AND EROSION CONTROL TOOLS

Description

Sediment and erosion control tools are structures or measures, located in runoff drainage channels or near culvert outlets, which prevent or reduce sedimentation and erosion of earth materials caused by direct rainfall, runoff, wind, freezing, gravity, or a combination of these. These tools may be mechanical(structural), vegetative, or a combination. Some measures are simply armor to resist erosive forces while others reduce erosive forces. These reducers of erosive forces include structures or measures to control runoff velocity, reduce the flow grade, or dissipate energy. Structures involve the use of pipe, rock rip rap, rock gabions, wood materials, concrete, prefabricated blocks, geotextiles, earth, vegetation, and many other innovative resources, ideas, and processes.

Importance to Maintenance & Water Quality

Today, many natural streams and channels have agraded from the influx of silts and sediments from farming operations and erosion along unpaved roadways. This agradation has filled many flood plains and wetlands which has diminished natures method of purifying water, led to increased flooding in low areas, and reduced or endangered fish and plant resources.

Sediment and erosion control structures protect the integrity of runoff drainage systems, roadways, and embankments by reducing degradation and agradation which can lead to roadway or bank failure, flooding, and/or recurring maintenance. Also, these structures and measures increase infiltration, reduce sedimentary pollutants which damage stream, lake, and pond ecosystems, and, reduce transport of debris which may accumulate and block channels and culverts.

Reducing runoff velocities and dissipating the energy contained within flowing water helps reduce and prevent the degradation of natural channels as well as man-made channels. Runoff volumes are reduced by the creation of better opportunities for infiltration. This becomes a two-fold benefit by decreasing the potential of erosion from overland flow while increasing groundwater recharge from increased infiltration. Streams, channels, and ditches have better opportunities to recover from scour and sedimentation by re-establishing or revitalizing vegetation growing within them and thus improving the ability of natural processes to filter and deliver runoff to creeks and rivers with less sediment accompanying it.

Implementation

Structures

Hay Bale Dikes

Very temporary structures constructed of rectangular hay bales tightly butted together, embedded four inches into the ground, and staked to the ground as shown in figure 6-1. Designed to temporarily impound or divert water, *not filter it*. Heavier, coarse sediments are settled out by the impoundment of water. The bales are too dense and not tall enough to act appreciably as filters. Use and installation technique is critical to proper performance.

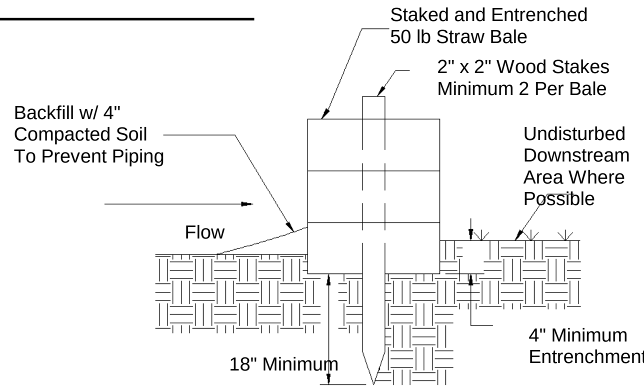


Figure 6-1. Hay Bale Dikes

Criterion For Use :

Hay bale dikes should be used ***only*** in areas of low flow velocity, such as; where concentrated flows are very low and enough upgrade storage capacity is available so that runoff is not likely to overflow the top of the hay bales, and, on areas of sheet flow, such as slopes and graded areas, where a series of these dikes may be placed cross-slope on the contour with ends turned up to prevent flow around them.

Hay bale dikes usually require closer spacing as land/channel gradients increase. This is necessary to create more storage and induce more infiltration, and thus prevent or reduce the potential of flow over-topping the bales. *Erosion on the backside of the hay bale structures, created from over-topping energy, may negate erosion control benefits created with the front-side settling of sediments.*

Use during seasons of low intensity storms and in areas where protection from sediment and erosive water flow is needed for durations of less than 60 days, such as;

a. Small construction sites/locations where individual structures are being constructed such as, drop inlets, permanent grade stabilization structures, pipes, culverts, grade work, etc. Hay bales are typically removed when these works are completed or shortly thereafter.

b. Seeded or sodded areas. In some cases, where aesthetics is not a concern, hay bales may be left in place after vegetation is established.

Whenever possible, remove sediment buildup from the front (upstream) side after every sediment depositing event. Do not allow sediment to accumulate closer than six (6) inches of the top of the lowest hay bale. Re-secure and tighten all hay bale dikes after every rainfall event and replace damaged bales.

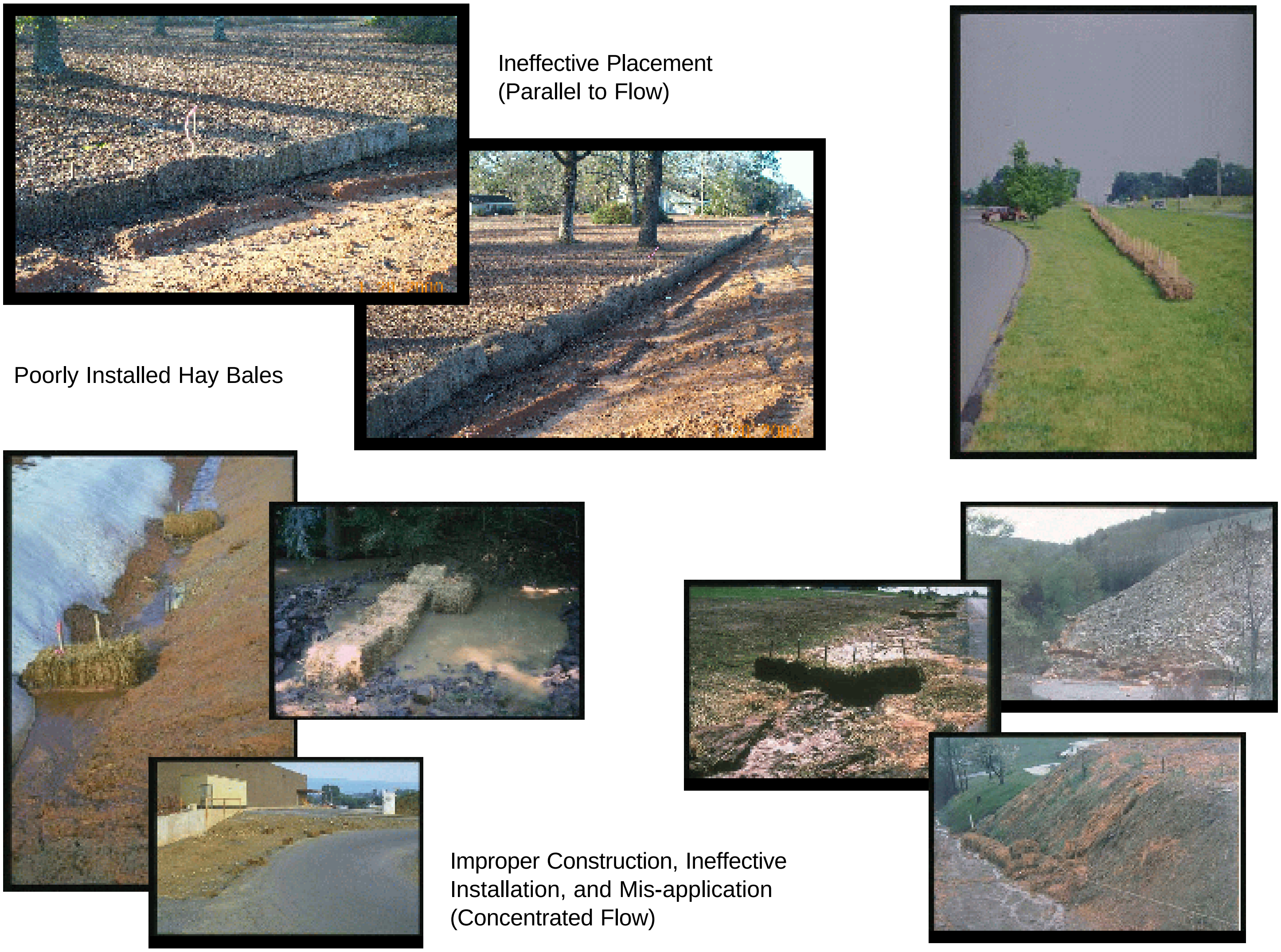


Exhibit 6.1a - Improper use and/or installation of hay bale dikes.

Exhibit 6.1b - Proper use and/or installation of hay bale dikes.
Exhibit 6.1 - Hay Bale Dikes

Exhibit 6.2a - Properly placed and erected silt fence.

Exhibit 6.2b - Improperly placed and erected silt fence.

Exhibit 6.2 - Silt Fence

Silt Fence

Temporary structure constructed of pervious geotextile fabric supported vertically by steel or wood posts. Designed to slow, temporarily impound, and filter sediment laden water. Sediments are settled out by the impoundment of water and filtered by the fabric, although filtration diminishes with sedimentation sealing the fabric pores. May be used to redirect runoff instead of impounding it. Installation technique and maintenance is critical to proper performance.

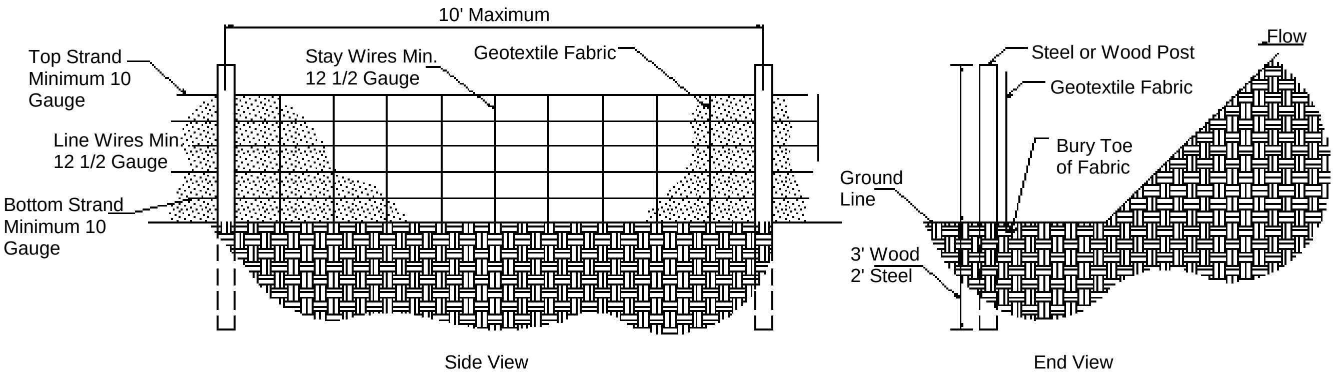


Figure 6-2. Silt Fence Details

Criterion For Use :

To be used only in areas of low flow velocity where concentrated flow volumes are low, and enough upgrade storage capacity is available where runoff will pond, then filter through the fabric or infiltrate, and not overflow the top of the fence. Common use areas include slope toes and outlets where sheet flow from slopes and graded areas can potentially carry sediment off site.

Silt fence filters usually require closer spacing as land/channel gradients increase. This is necessary to create more storage and induce more infiltration, and thus prevent or reduce the potential of flow over-topping the fence.

Use in areas where protection from sediment and erosive water flow is needed for an indefinite period of time, such as;

a. Large or small sites/locations where individual structural units are being constructed such as, drop inlets, permanent grade stabilization structures, pipes, culverts, grade work, etc.

b. At the perimeter of disturbed areas where runoff leaves the site.

c. Seeded or sodded areas. In some cases, where aesthetics is not a concern and the structure poses no adverse conditions, silt fences may be left in place after vegetation is established.

Whenever possible, remove sediment buildup from the front (upstream) side after every significant sediment depositing event. Do not allow sediment to accumulate closer than half way of the top of the lowest point in the fence. Re-secure and tighten fencing and fabric after every significant runoff event, especially checking the toe of the fabric for breaches.

Rock Ditch Check/Check Dam

Semi-permanent to "permanent" structure composed of stone, as shown in figure 6-3, which will eddy water behind it, settle out sediment, and allow water to pass through and/or over its crest. Once sediment has filled in behind the structure the active function of collecting sediment will cease, however, it will continue to act as a stabilizing force for the ditch bottom grade.

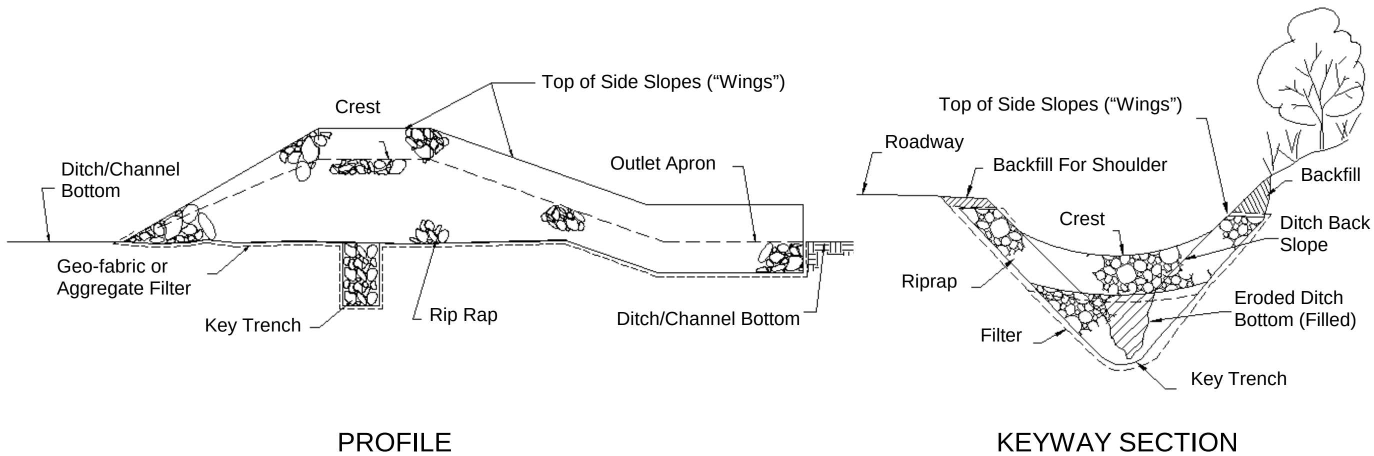


Figure 6-3. Rock Ditch Check/Check Dam Details

The roadway crown, shoulder, and ditch bottom elevations must be maintained constant for as long as possible to extend the life of these structures and make them cost effective. Unchecked roadway degradation renders these stationery structures useless and may allow them to become accelerants to erosion rather than aids against it.

For optimum performance, these structures must be designed by a professional engineer, meticulously installed, and rigorously maintained. Structures must be embedded into the side banks, toed into the channel bottom at the outlet, and have a flow channel deep enough to handle normal runoff to minimize the potential for over-flow scour around the edges. Also, there should be enough outlet apron to dissipate the energy of water overflowing the crest to protect the toe from the undermining scour which leads to failure. A toe-wall at the end of the apron is often necessary. Continual maintenance is critical until the structure has stabilized and "seated" itself.

Lateral runoff from adjacent roadway surfaces or back slopes must be directed safely into the ditch or structure to prevent washout along the edges of the structure. Construct the structure of stone large enough, or otherwise secured in place (ie. grouted, gabion, etc.), to resist expected velocities. A geotextile fabric or aggregate filter should lay between all stone to ground contact surfaces, with overlap at fabric seams, and fabric or aggregate overlapping the exposed edges at the surface as shown in figure 6-3.

Level Spreader

Semi-permanent to permanent trench used to spread, and discharge water flow over a wide area. This structure reduces concentrated flow, increases infiltration, and allows for sediment to be removed by settling and filtering. Level spreaders are generally used at the toe of a slope, but can be used to intercept concentrated runoff and disperse it across the head (top) of a slope or grade. This application can be useful in protecting road banks from concentrated flow entering from upland drainage areas.

As shown in figure 6-4, it is constructed as a water impounding channel or trench, cut on a level contour into a slope or grade. The front (downslope) edge allows shallow discharge over its entire length when the impoundment is full. The impoundment should be shallow, but deep and wide enough to reduce surface turbulence from the runoff inflow allowing the water to evenly fill the impoundment and then flow smoothly over the discharge point along the front edge no deeper than 1/2" at peak design flow. The impoundment will catch sediment and will require periodic clean-out maintenance.

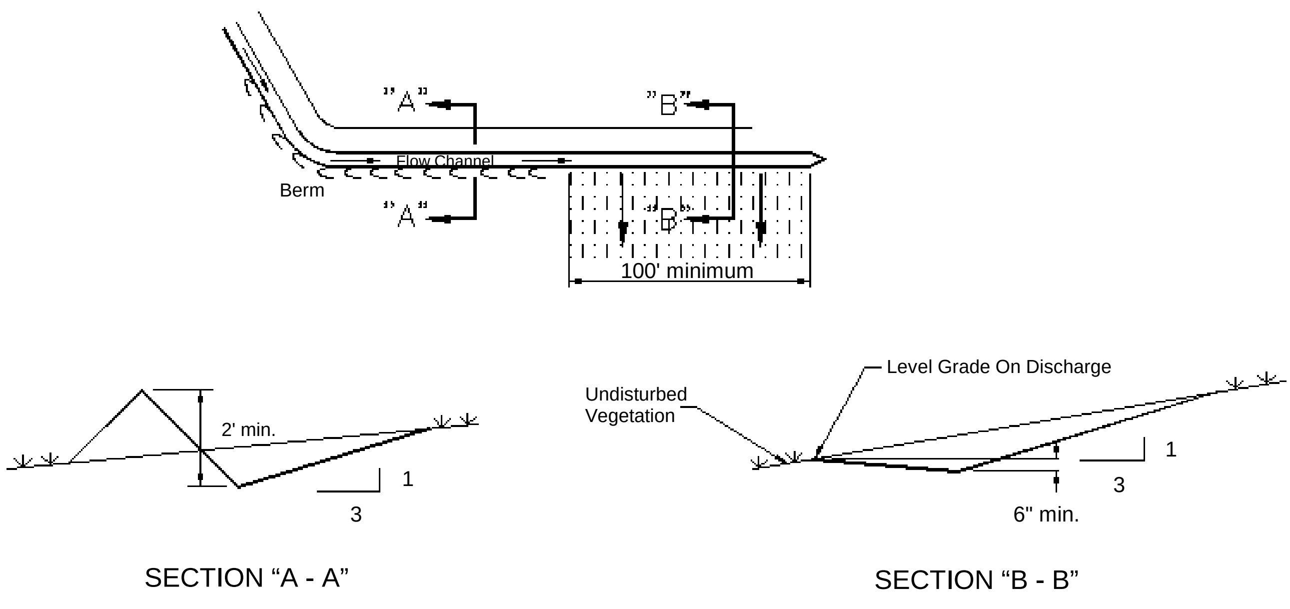


Figure 6-4. Level Spreader Details

Log and Brush Check Dam

Semi-permanent or temporary structure constructed of brush intermeshed with logs staked to the ground or arranged across the channel as shown in figure 6-5 below. Geotextile fabric may be placed across the front face of the structure for added performance. These structures are designed to slow, temporarily impound, and filter sediment laden runoff. Sediments are settled out by the impoundment of water, and filtered by the brush and fabric. Installation technique is critical to proper performance.

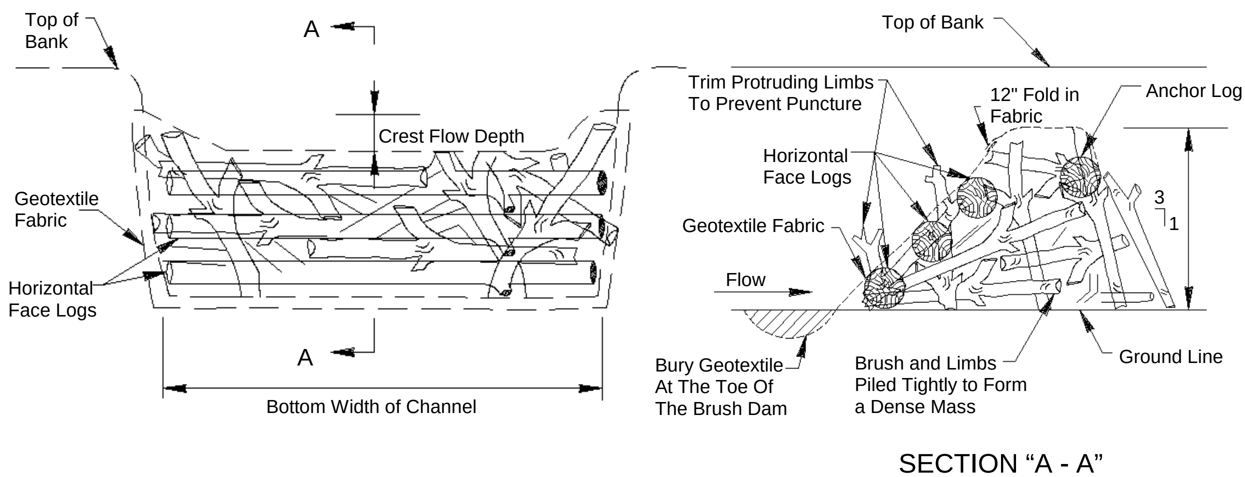


Figure 6-5. Log and Brush Check Dam Details

These structures are intended to be used in areas of high flow velocity and moderate concentrated flows. The structure should be designed for a given storage capacity where the design runoff will pond, then filter through the structure. Excess storm flow will overflow the top of the structure or will bypass, as per design, onto a stable outlet.

These structures are not likely to be used within road right-of-ways, however, there are feasible applications in specific situations where easements, public lands, or other permissible locations exist. Specifically, these structures will be used in areas where sediment detention is needed for an extended period of time, such as; road turn-outs, swales, ditches, intermittent streams, or other areas receiving concentrated flow from disturbed or fallow (bare) areas. Structures should be placed as near as possible to the perimeter of the disturbed areas where runoff leaves the site.

Other locations are low flow perennial streams below road crossings or other places where land disturbance due to construction and/or maintenance is taking place. These structures will almost always require removal after stabilization of disturbed area, however, they may be left in place if determined by the engineer that no adverse effects to the stream and surrounding hydrology will occur. Sediment from the disturbed area, accumulated by the structure, should be removed and properly disposed as needed until re-stabilization is complete. Remove sediment buildup from the front (upstream) side before it accumulates within half way of the top of the lowest point in the structure.

Sediment Trap

Temporary basin created by either excavation, earth or rock embankment, or a combination of these to intercept, trap, and retain sediment from runoff while allowing detained runoff to slowly drain, infiltrate, or both. Sediment laden runoff can be drained and filtered by perforated pipe, rock filtration and/or rock dam seepage, infiltration, or a combination of these. These structures are usually used during construction or maintenance practices. They are easily and economically constructed and offer versatility of location. Materials used to construct them can be demolished and constructively used or disposed on site when the structure's service area has been adequately stabilized.

Because of the predominantly temporary nature of these structures, they usually require removal of collected sediment after each runoff event to restore adequate operating capacity and are constructed with an emergency bypass for excessive runoff events. Larger sediment traps with extended sediment retention capabilities and large drainage areas should be designed by a professional engineer experienced in hydrology. "Rule of Thumb" criteria, developed by a professional engineer, may be used for local (countywide) application for limited size watersheds.

Sediment Basin

Semi-permanent to permanent version of the Sediment Trap constructed by either excavation, embankment, or a combination of these to intercept, trap, and retain sediment from runoff while allowing detained runoff to slowly drain, infiltrate, or both. These structures, illustrated in figure 6-6, are used for indefinite periods of sediment collection associated with long term disturbance of the earth such as mining, farming, unpaved road drainage, etc. Sediment and runoff storage capacities are often larger than sediment traps, and embankments are usually constructed of more permanent materials such as compacted earth, rock, concrete, etc. Sediment laden runoff can be drained and filtered by perforated pipe, rock filtration, rock dam seepage, infiltration, pumping, or a combination of these. Three "clean water" drainage or discharge methods are described below.

Riser pipe and barrel - The top section of risers are most often perforated, but may not be, depending on storage volume of the basin, percolation/recovery rate, probable peak runoff volumes, other basin drainage mechanisms, or any combination of these.

Riprap/aggregate filter dam - This porous dam is constructed at least one foot higher than height at maximum design runoff retention volume. Runoff will drain through riprap and/or coarse aggregate leaving behind sediment. Rock in the dam may need cleaning and re-mixing to improve permeability when in use for extended periods or when frequent, sediment laden discharges have entered the structure. By-pass is usually the top of the dam.

Underdrain filter - An aggregate-shrouded pipe network buried at the bottom of the basin. This system is for a more elaborate, structure and works best where the basin is constructed in sandy soils. May be used in conjunction with other discharge methods.

A professional engineer experienced in hydrology should be consulted for design of these structures. Ideally, sediment basins should be elongated in the direction of flow with the length at least twice the width to obtain the most effective settling of sediments. Depth should be determined based on length and width dimensions and volume requirements for runoff storage plus sediment retention. Consideration may be given to outflow and/or infiltration versus inflow in determining runoff detention volume.

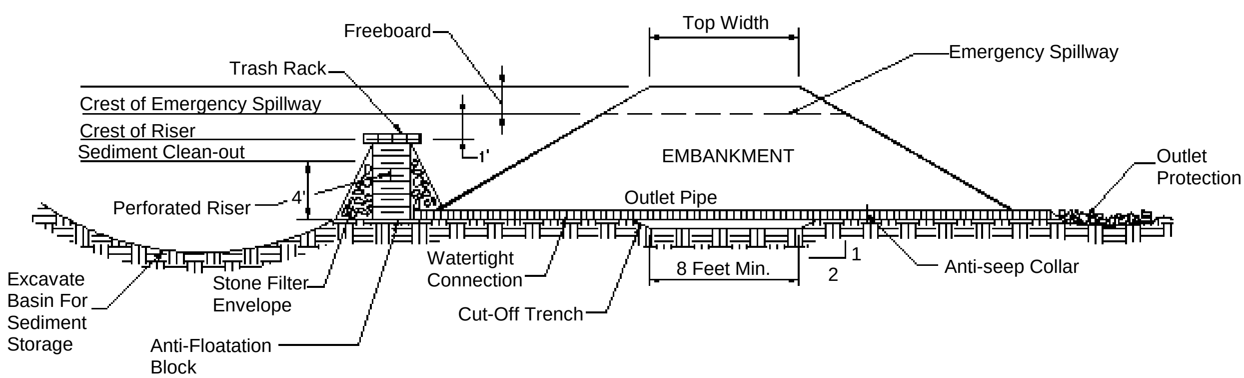


Figure 6-6. Sediment Basin Illustration

Riparian Buffer

Area or strip of undisturbed vegetation between sensitive areas such as streams, wetlands, ponds, etc. and areas of land disturbance and/or fallow (bare) ground such as unpaved roads, construction sites, etc. as illustrated in figure 6-7. Ideally the vegetation consists of trees, shrubs, brush, grass, various under story vegetation, and bio-mass (dying and decaying plant materials). Riparian buffers can be naturally existing or may be designed and planted.

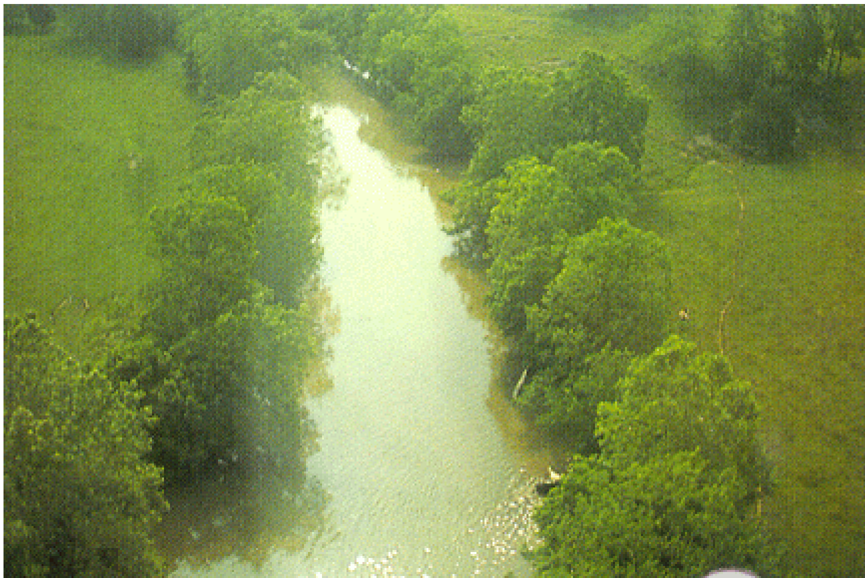
Left Side Basin

Right Side Basin

Typical Sediment Basin Use on an Unpaved Roadway

Other Types of Sediment Basins

Exhibit 6.3 - Sediment Basins



Established Riparian Buffers

Planted Riparian Buffers

Exhibit 6.4 - Riparian Buffers

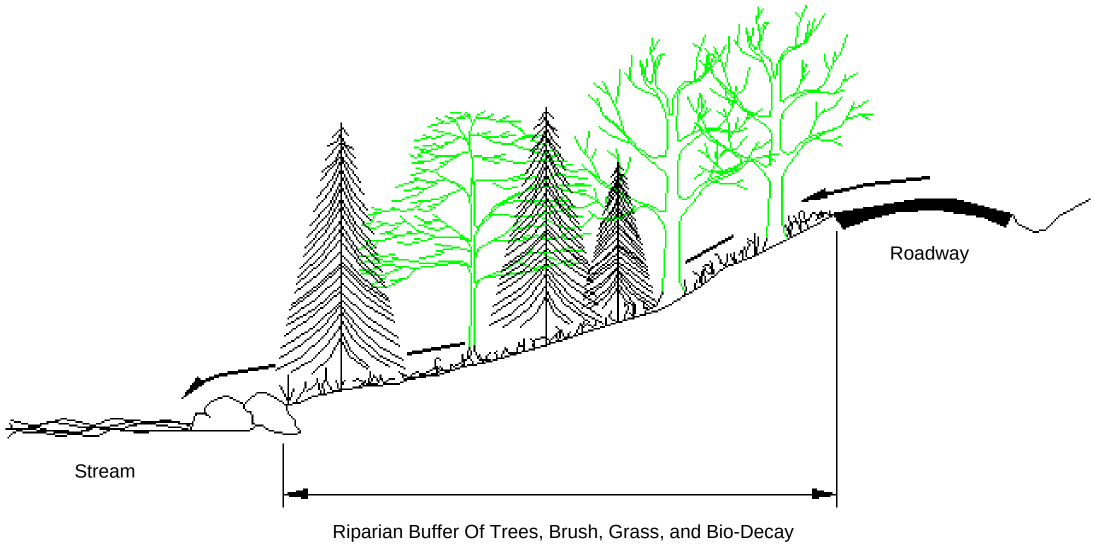


Figure 6-7. Riparian Buffer Illustration

Road ditches, turn-outs, and other water disposal systems from roadways should empty into a riparian buffer, whenever possible, before entering sensitive areas. The discharge from these disposal systems should be fanned (spread out) as much as possible as it transitions from the concentrated channel to the riparian buffer (see Figure 6-4, Level Spreader Details). The distance from concentrated discharge to sensitive areas should be adequate to allow vegetation to grow through and stabilize deposited sediments. The minimum distance should be fifty feet.

Riparian buffers may become filled and damaged from excessive sedimentation. This may require additional spreading of the runoff or delicate removal of sediment from the buffer. In either case, a need for additional upland sediment control is indicated.